

The Art of Light Measurement

Avantes BV
Apeldoorn, The Netherlands

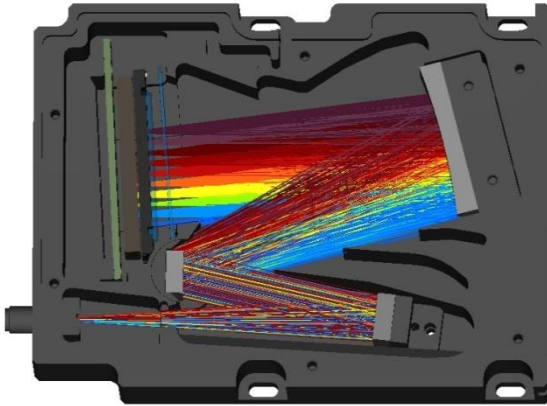


Who am I?

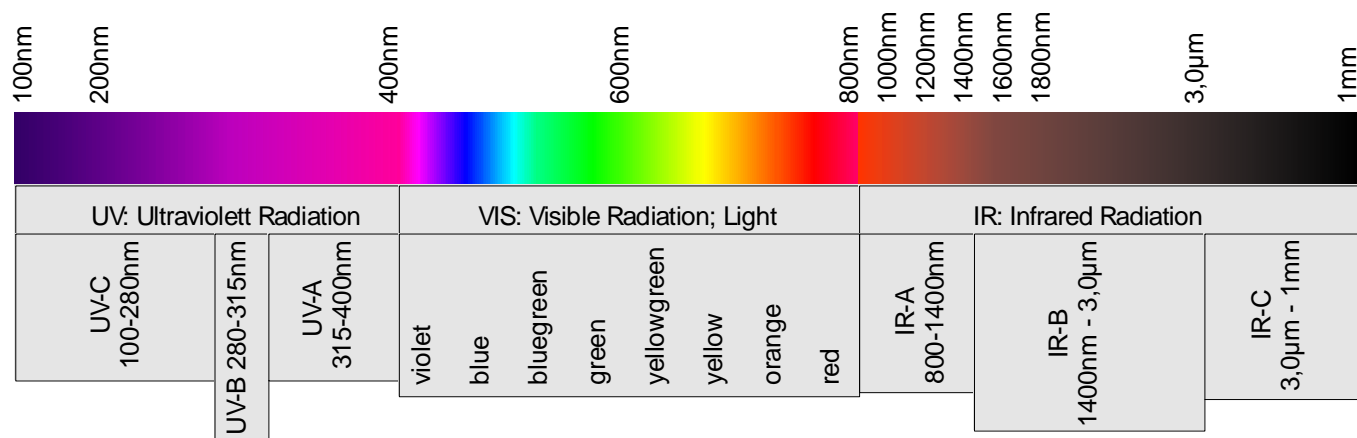
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Develops, Produces and worldwide distributes spectrometers , fiber optics and accessories. Spectrometers are devices to measure Wavelengths/ light.

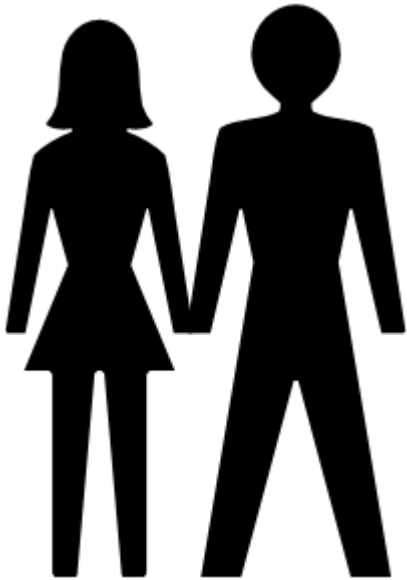




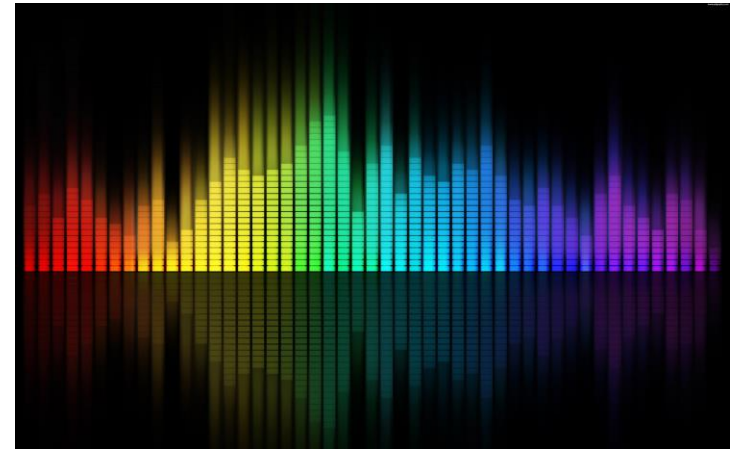
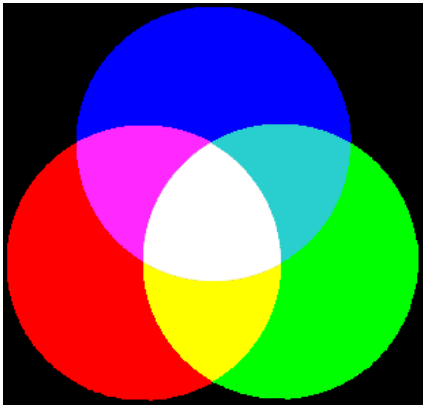
Light



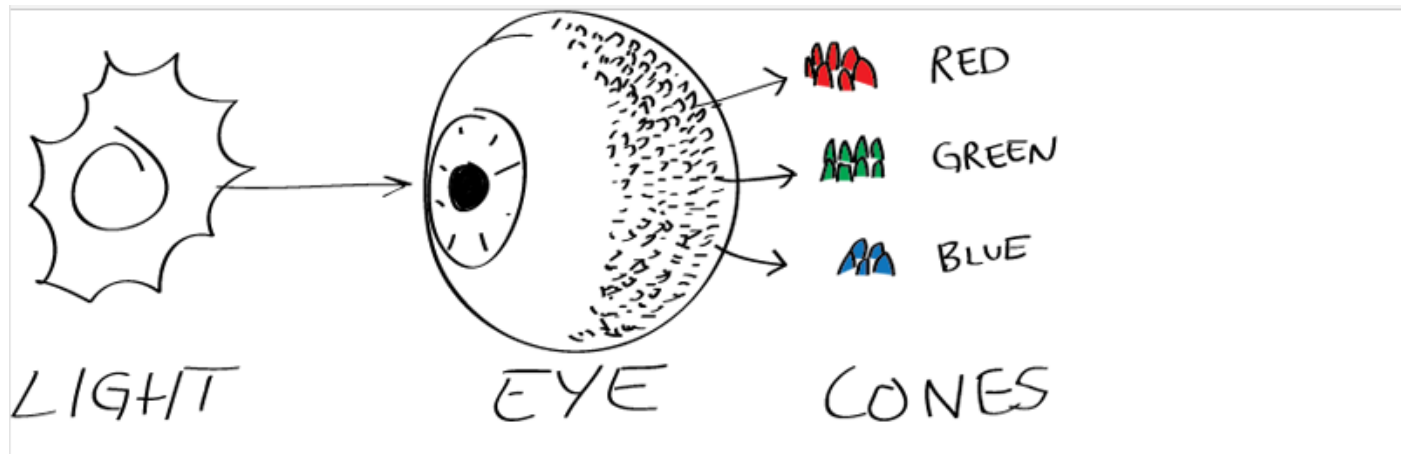
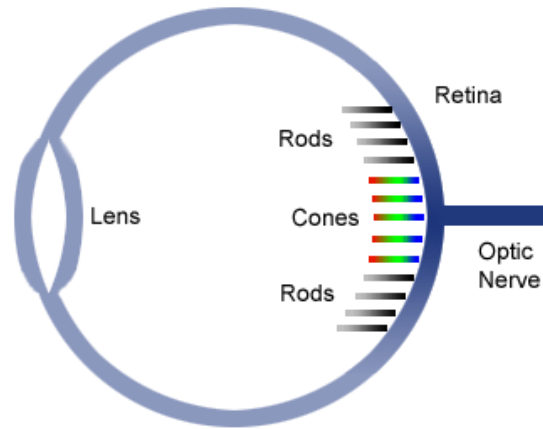
Man, Eye, Reflection, Perception



Color, Intensity, Spectral

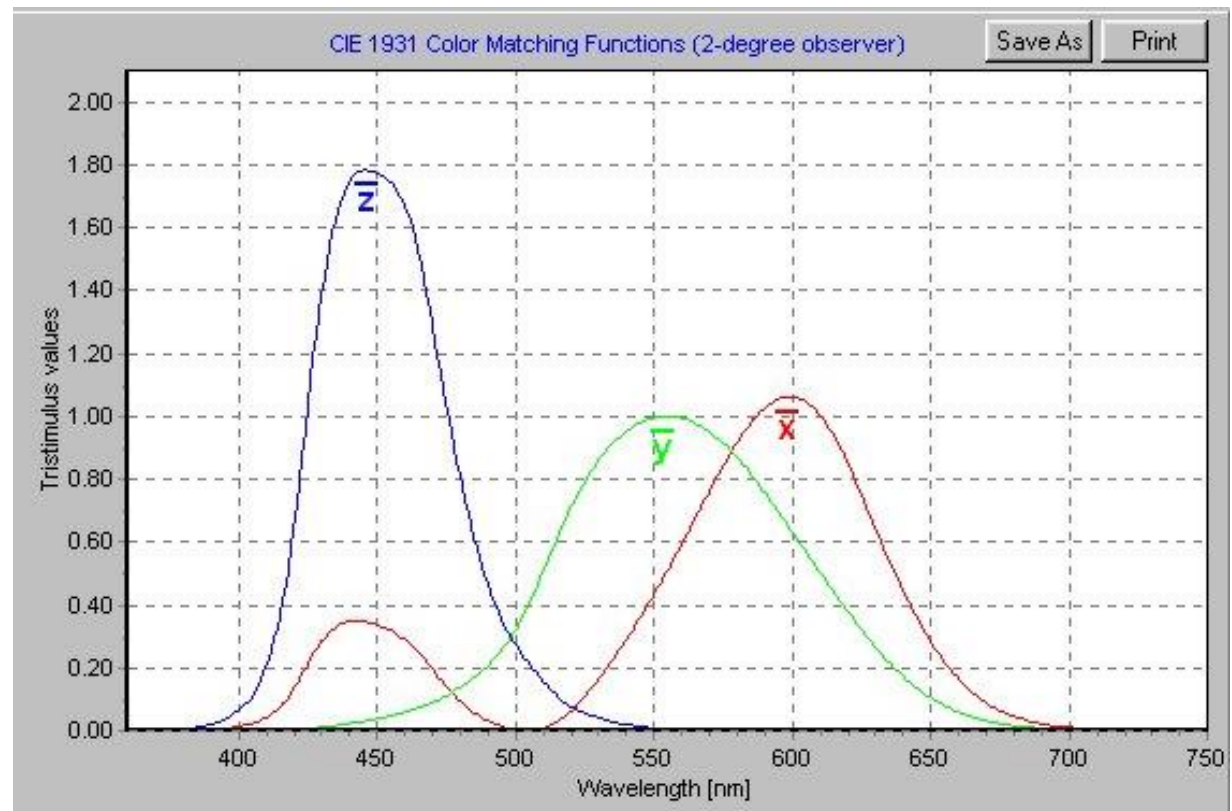


Color - Human eye



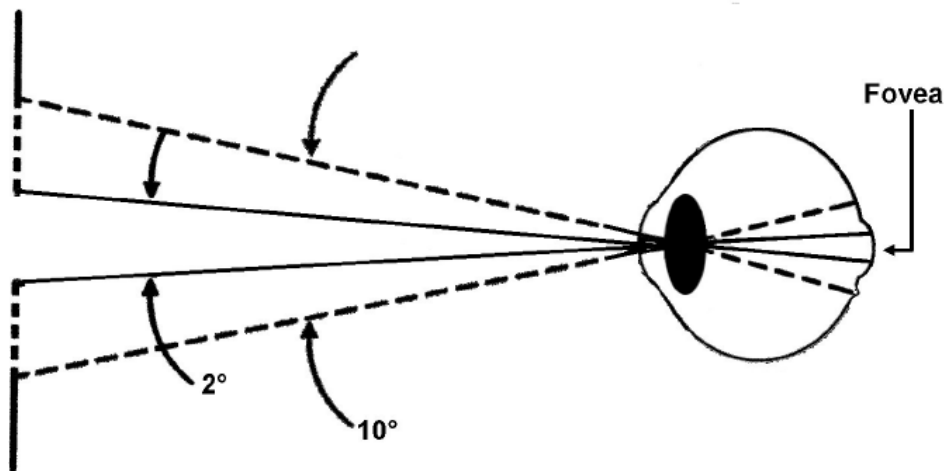
Colorimetry - human eye color perception

- ✓ X, Y, Z tristimulus
- ✓ CIE 1931 2° observer
- ✓ CIE 1964 10° observer

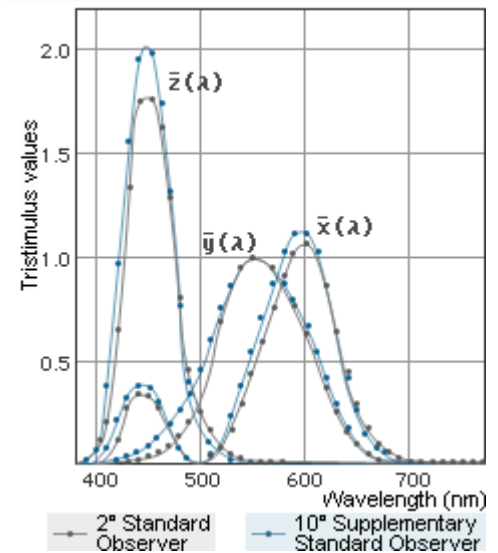


2 and 10 degree observer

2° - 10° Observer

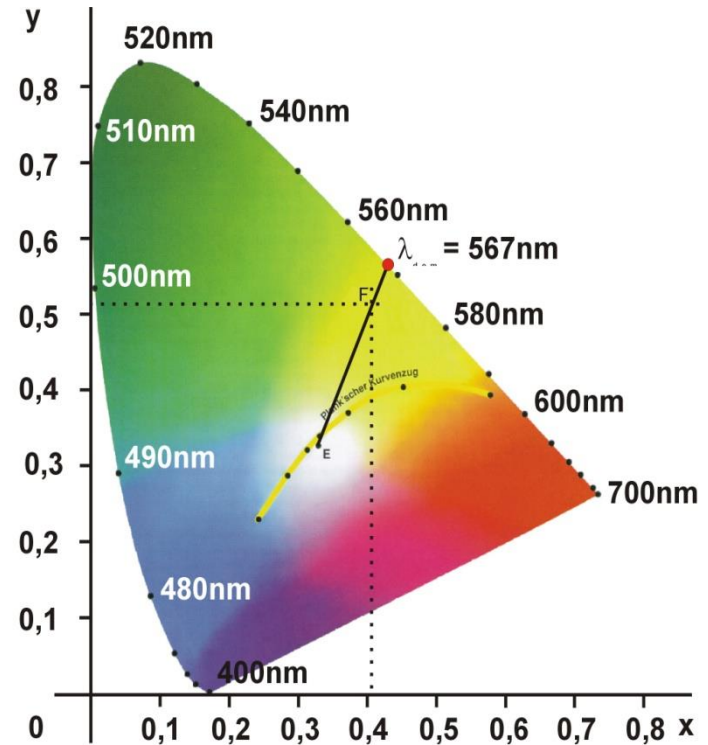


Color-matching functions



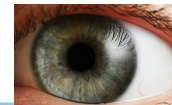
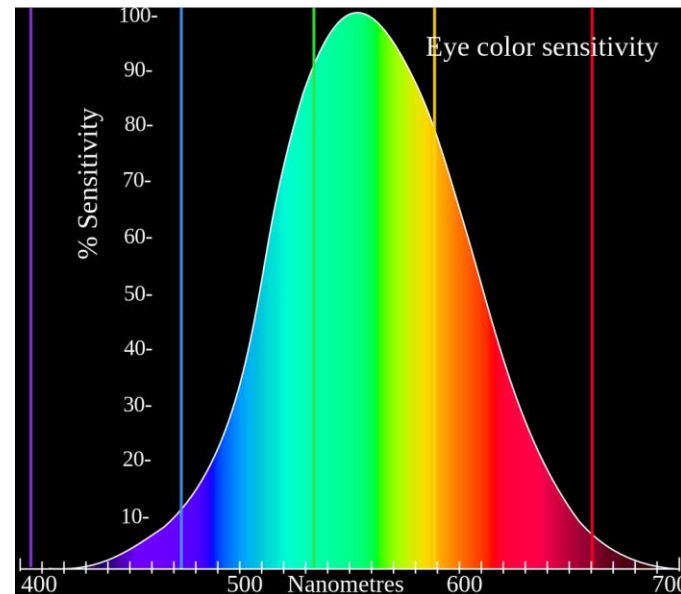
CIE 1931 Chromaticity Diagram

chromaticity
coordinates x,y
 $x = X / (X + Y + Z)$
 $y = Y / (X + Y + Z)$



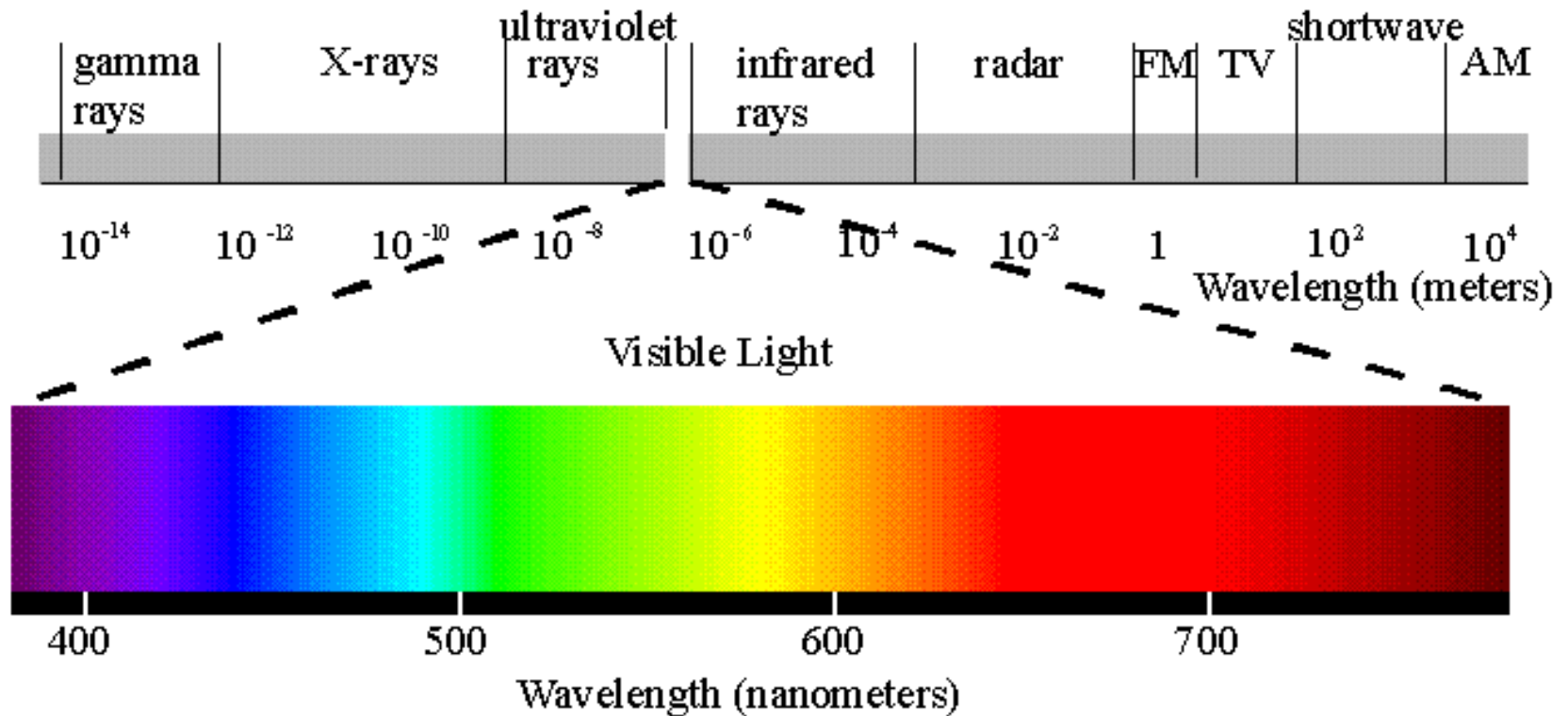
Radiometry deals with the measurement of all optical radiation inclusive of the visible portion of this radiant energy

Photometry deals with the measurement of visible light energy as perceived by the human eye.





Lightspectrum



Parameters

Radiant flux:
Watt (radiometric flux)

Irradiance:
 W/m^2 (radiom. flux per unit area)

Radiant intensity:
 W/sr (radiom. flux per unit solid angle)

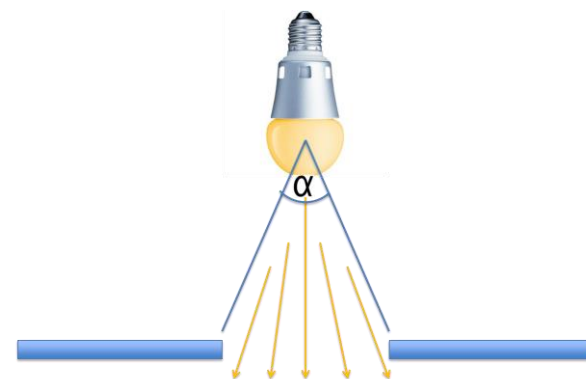
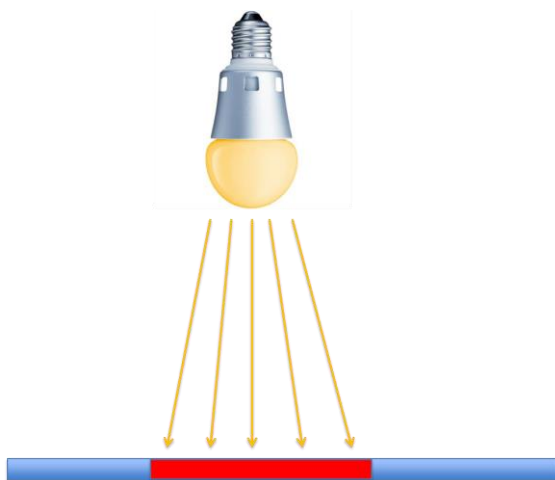
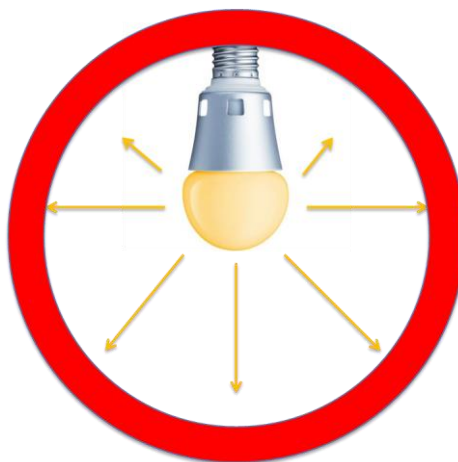
Radiance:
 $\text{W/m}^2/\text{sr}$ (radiom. flux density per unit solid viewing angle)

Luminous flux:
Lumen (photometric flux)

Illuminance:
 lm/m^2 (photom. flux per unit area)

Luminous intensity:
 lm/sr (photom. flux per unit solid angle)

Luminance:
 $\text{lm/m}^2/\text{sr}$ (radiom. flux density per unit solid viewing angle)



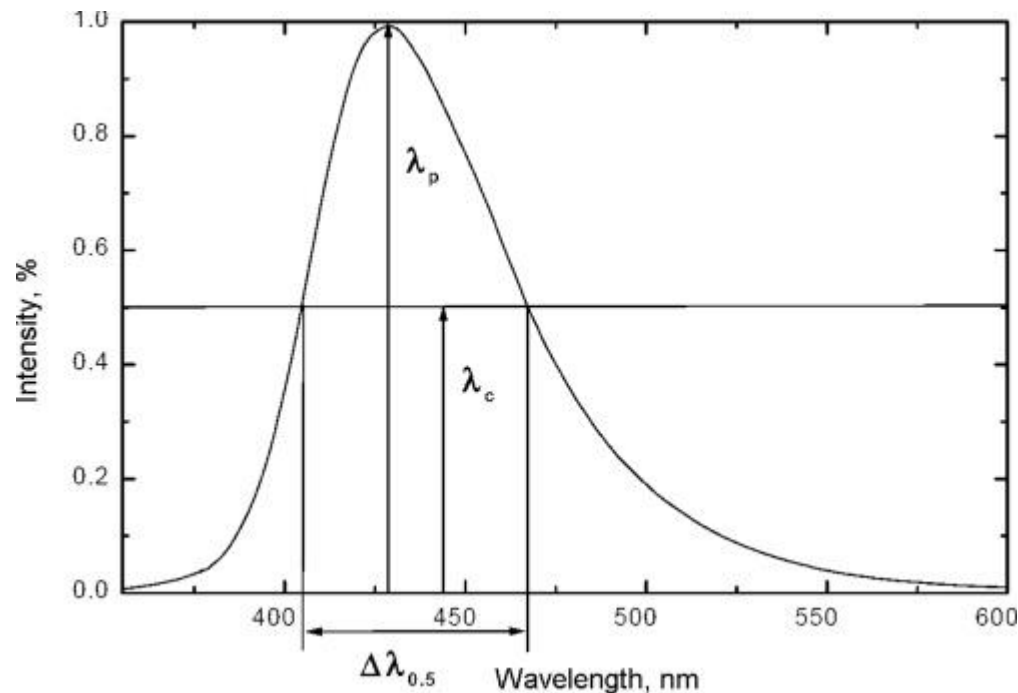
Peak wavelength λ_p

Spectral width (at half intensity levels)

- also denoted as $\Delta \lambda$ (FWHM).

Centroid wavelength λ_c

“center of gravity wavelength”



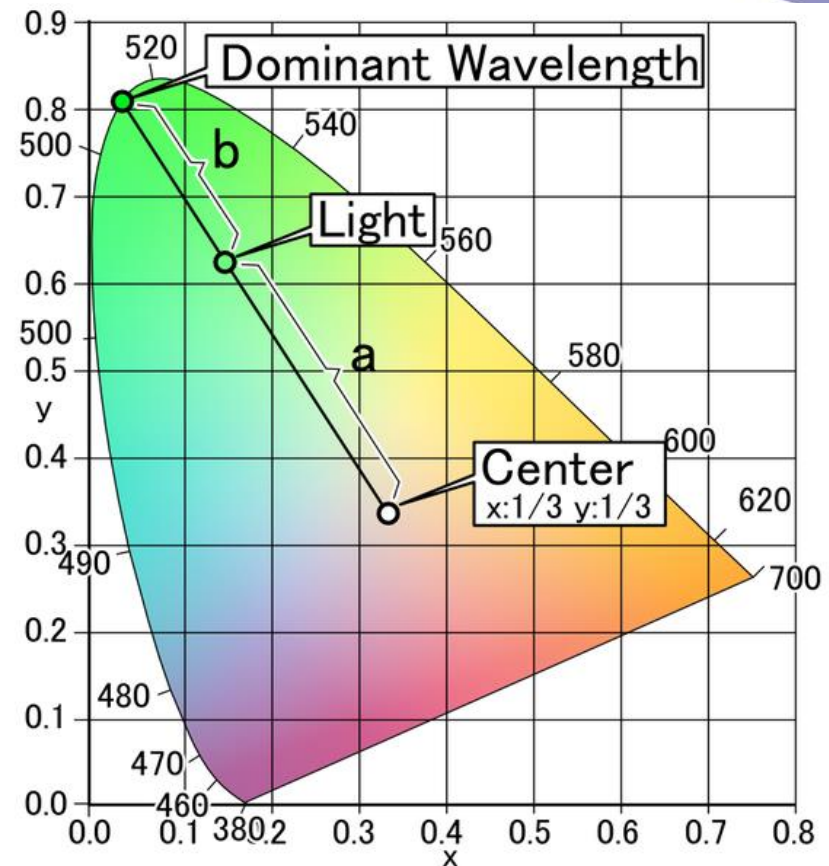
Dominant wavelength (DW)

A straight line from the white point E to the measured color coordinates intersects the boundary of the color diagram at the dominant wavelength.

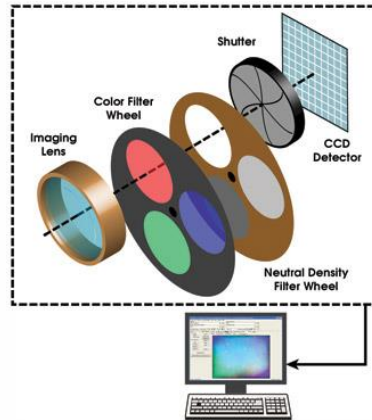
Purity: $a/(a+b)$

Is the ratio of the length of the line from the white point E to the chromaticity point and the length of the line from E to the boundary of the chromaticity chart.

Purity is always given in %.



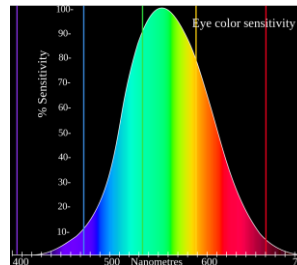
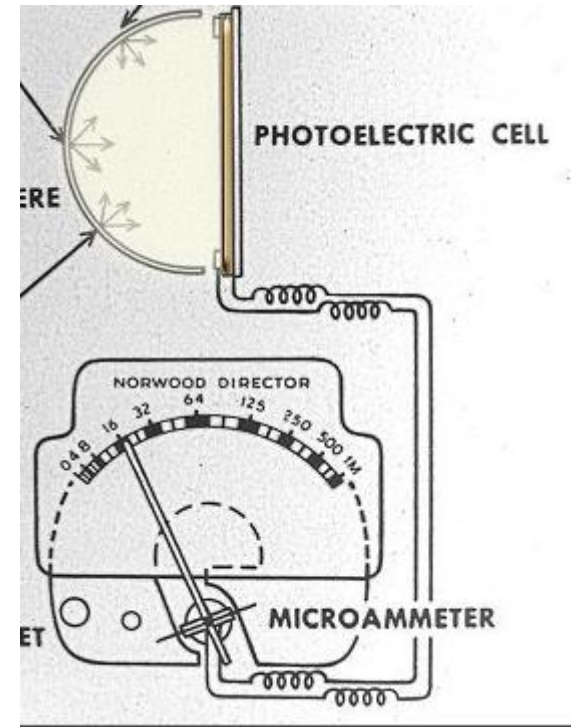
Photometer, Colorimeter, Spectrometer



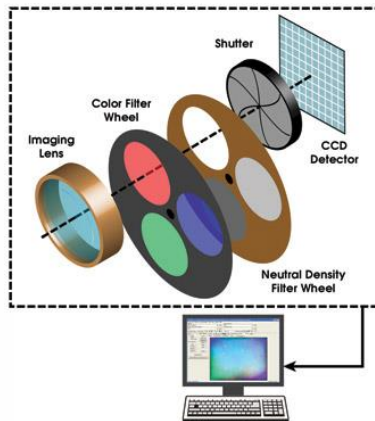
Photometer/ Lightmeter



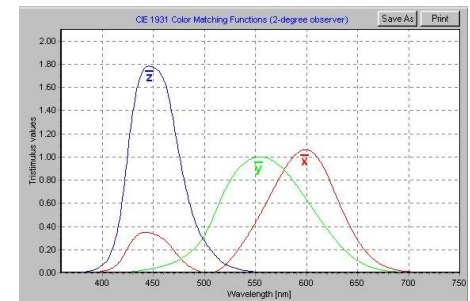
Filter - detector - readout
Gives 1 value / No spectral information



Colorimeter

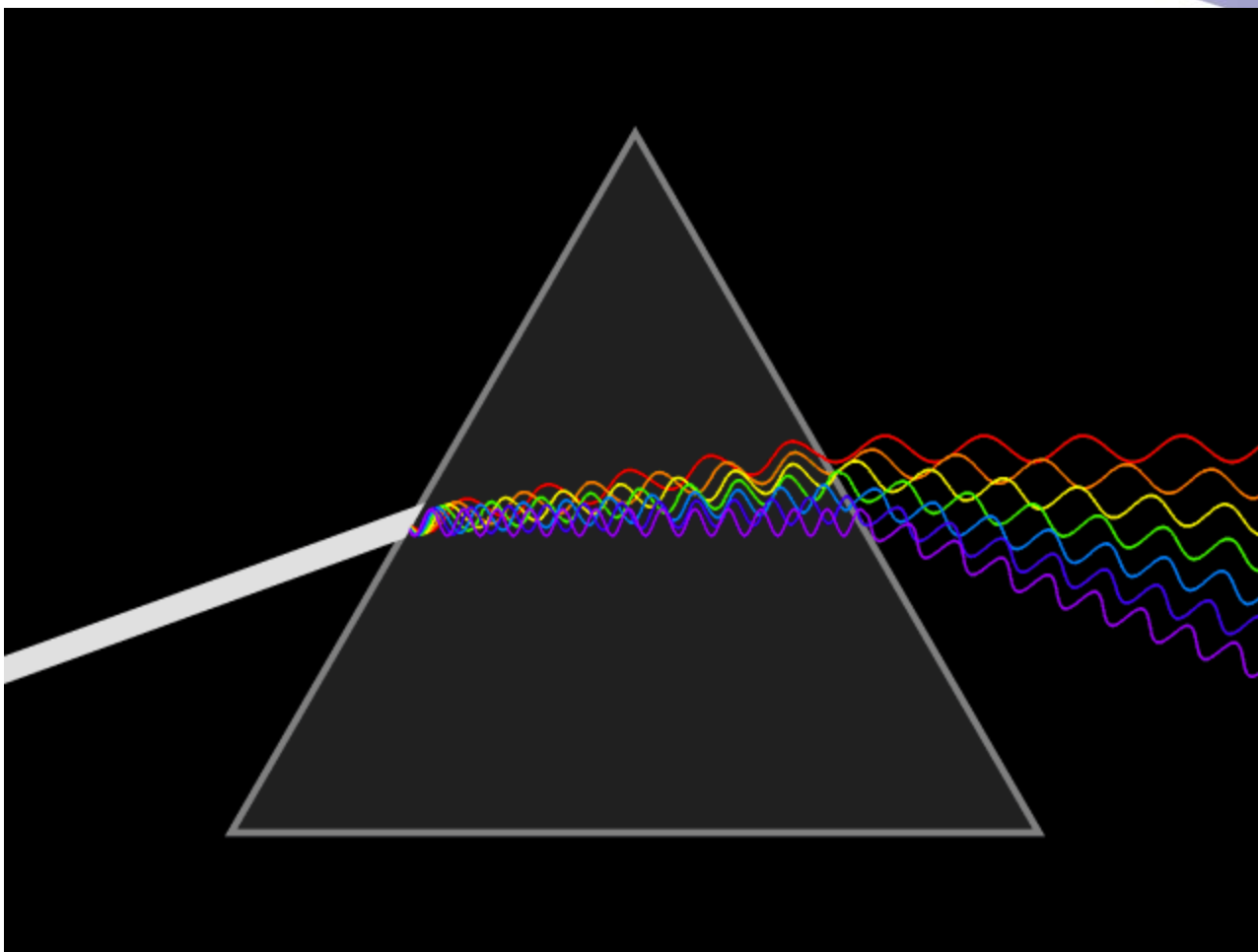


Obtains color information (XYZ)
Based on physical filters
3-4 “snapshots”

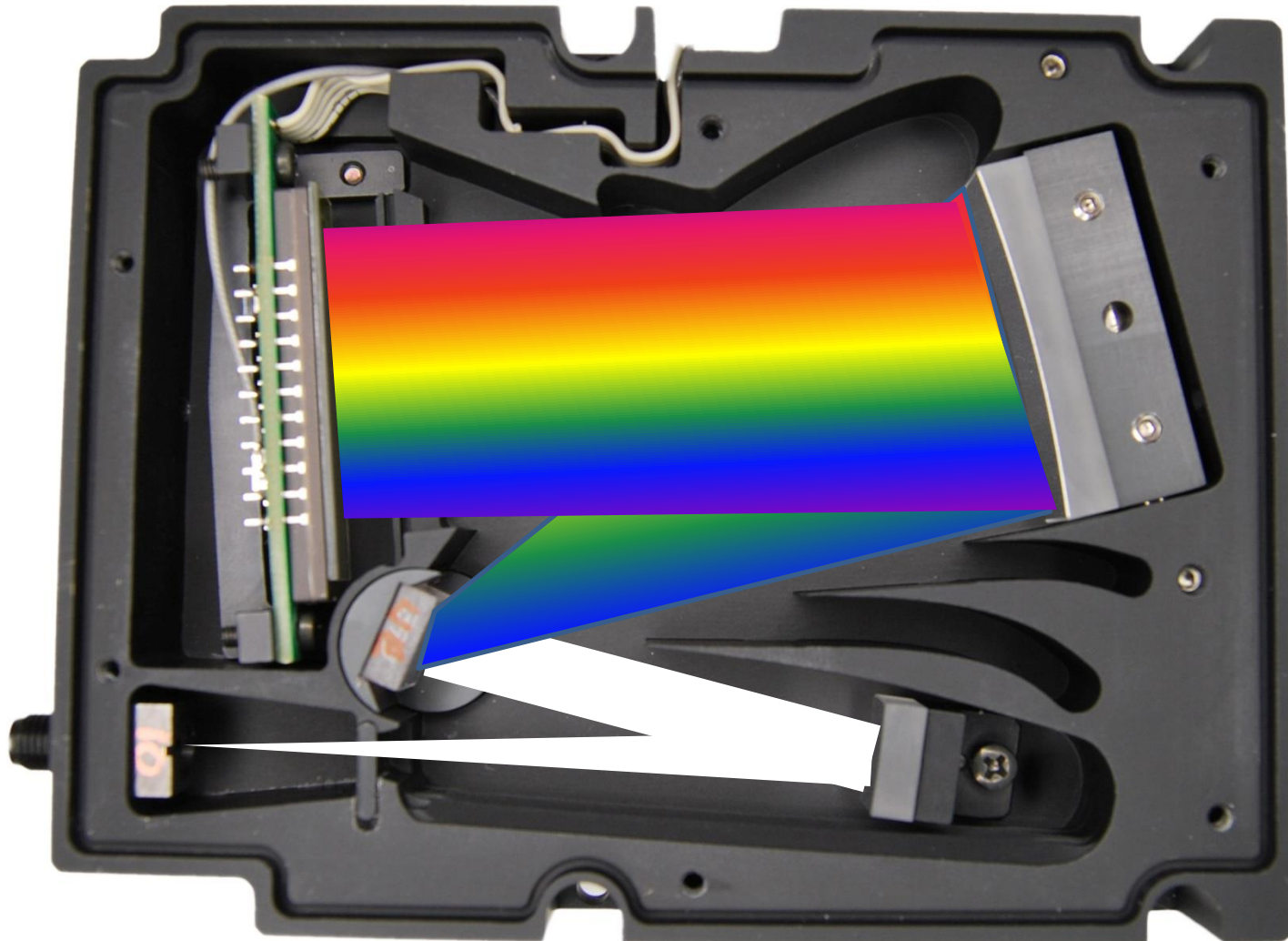


Spectrometer

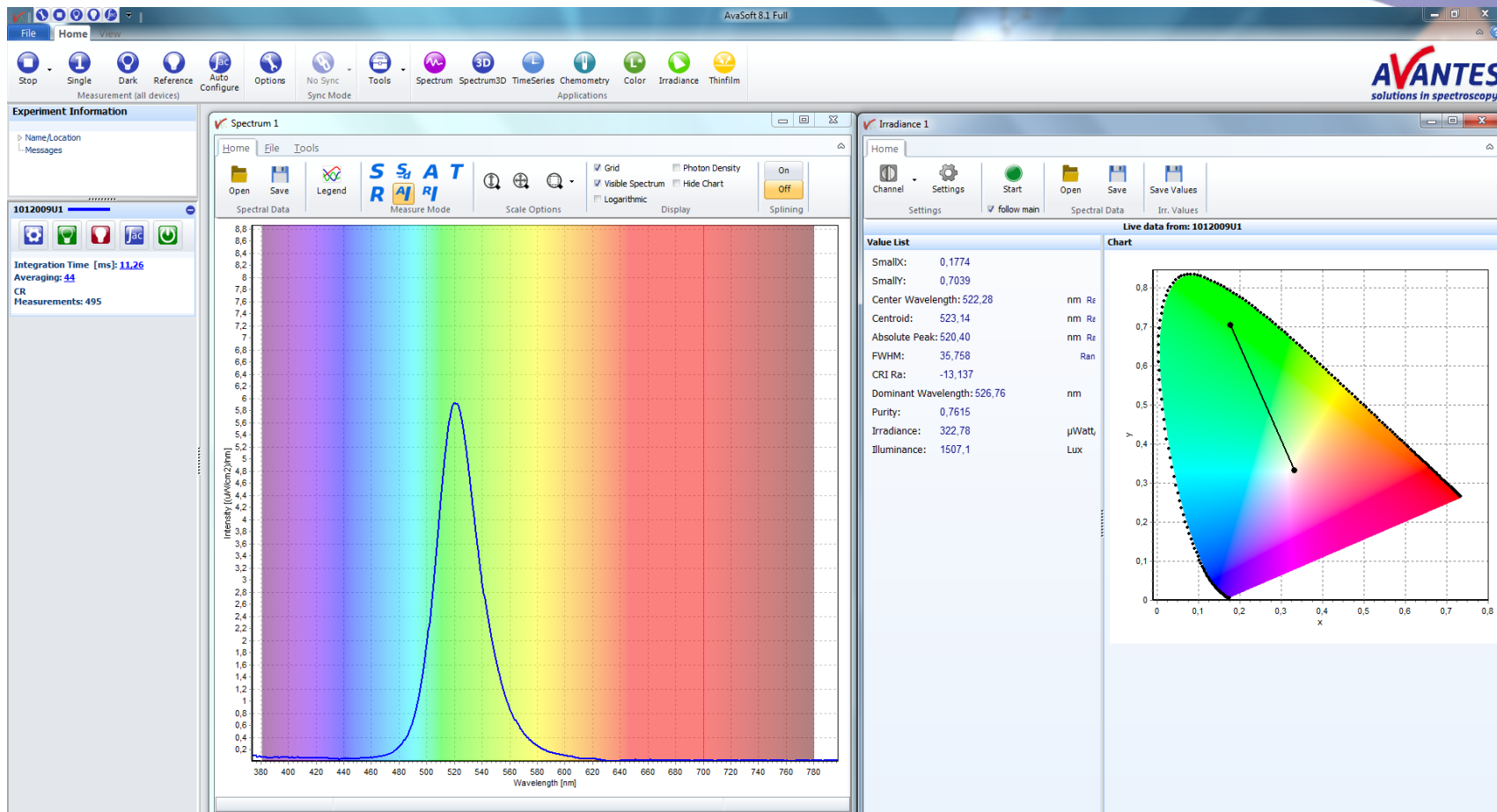




Spectrometer - the core technology



AvaSoft Irradiance chart



Standards

Standards Google results - Standards Light

Standards and projects under the direct responsibility of ISO/TC 274 Secretariat

✦ Standard and/or project	✦ Stage	✦ ICS
✓ ISO 8995-1:2002 (CIE S 008/E:2001) Lighting of work places -- Part 1: Indoor	90.93	13.180 91.160.10
✓ ISO 8995-3:2006 (CIE S 016/E:2005) Lighting of work places -- Part 3: Lighting requirements for safety and security of outdoor work places	90.60	13.180 91.160.10
✓ ISO 11664-1:2007 (CIE S 014-1/E:2006) Colorimetry -- Part 1: CIE standard colorimetric observers	90.93	17.180.20
✓ ISO 11664-2:2007 (CIE S 014-2/E:2006) Colorimetry -- Part 2: CIE standard illuminants	90.93	17.180.20
✓ ISO 11664-3:2012 (CIE S 014-3/E:2011) Colorimetry -- Part 3: CIE tristimulus values	60.60	17.180.20
✓ ISO 11664-4:2008 (CIE S 014-4/E:2007) Colorimetry -- Part 4: CIE 1976 L*a*b* Colour space	90.93	17.180.20
✓ ISO 11664-5:2009 (CIE S 014-5/E:2009) Colorimetry -- Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram	90.92	17.180.20
✎ ISO/DIS 11664-5 Colorimetry -- Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram	40.99	17.180.20
✓ ISO/CIE 11664-6:2014 (CIE S 014-6/E:2013) Colorimetry -- Part 6: CIEDE2000 Colour-difference formula	60.60	17.180.20
✓ ISO 15469:2004 (CIE S 011/E:2003) Spatial distribution of daylight -- CIE standard general sky	90.93	17.180.20
✓ ISO 16508:1999 (CIE S 006.1/E:1998) Road traffic lights -- Photometric properties of 200 mm roundel signals	90.93	93.080.30
✓ ISO 17166:1999 (CIE S 007/E:1998) Erythema reference action spectrum and standard erythema dose	90.93	17.180.20
✓ ISO/CIE 19476:2014 (CIE S 023/E:2013) Characterization of the performance of illuminance meters and luminance meters	60.60	17.180.20
✓ ISO 23539:2005 (CIE S 010/E:2004) Photometry -- The CIE system of physical photometry	90.93	17.180.01
✓ ISO 23603:2005 (CIE S 012/E:2004) Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour	90.93	17.180.20
✎ ISO/DIS 28077 Photocarcinogenesis action spectrum (non-melanoma skin cancers)	40.99	13.280 17.180.20
✓ ISO 28077:2006 (CIE S 019/E:2006) Photocarcinogenesis action spectrum (non-melanoma skin cancers)	90.92	13.280 17.180.20
✓ ISO 30061:2007 (CIE S 020/E:2007) Emergency lighting	90.93	91.160.10

Standards LM-79

LM-79 is a procedure of photometric testing for LED luminaires. It's an IESNA document that the photometric laboratories must follow to test the LED luminaires. Basically it tells you how the luminaire must be tested and what information must be included in the photometric report.

A photometric report according to LM-79 will contain the luminaire's photometric data (lumens, vertical distribution of the lumens, color temperature...) and electric data (power, current)

Standards - NIST

- ANSI-NEMA-ANSI C78.377-2008 Specifications for the Chromaticity of SSL Products
- IES LM-79-08 Electrical and Photometric Measurements of SSL Products
- CIE 127:2007 Measurement of LEDs, 2nd edition
- IES LM-80-08 Measuring Lumen Maintenance of LED Light Sources
- Addendum a (6.8 Light Emitting Diodes) to ANSI/IESNA RP-16-05 Nomenclature and Definitions for Illuminating Engineering.

[Yoshi Ohno](#),

Standards continuously change

LED Magazine - IKEA start vc

IES publishes TM-30 def X

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← → ↺ 🏠

ledsmagazine.com/articles/2015/08/ies-publishes-tm-30-defining-new-color-metrics-for-characterizing-lighting.html


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home / Services and Testing / IES publishes TM-30 defining new color metrics for characterizing lighting


IES publishes TM-30 defining new color metrics for characterizing lighting

Published on: August 19, 2015
By [Maury Wright](#)
Editor in Chief, LEDs Magazine


Long-sought replacement for CRI color metric that more accurately characterizes SSL and legacy light sources is at hand in the IES, and has been proposed to the CIE.



The Illuminating Engineering Society (IES) has published a new Technical Memorandum — TM-30-15 entitled "IES Method for Evaluating Light Source Color Rendition" — that promises to supplant CRI as a color metric. TM-30 relies on concepts of fidelity



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Set up depends

Not an easy answer.

Official data, reproducibility check, indication, ...

Line of business, geographical,-> Standard

Standard - Describes what/ how to be measured

What to be measured defines best instrument

Avantes can play a part in it ... a good spectrometer based system to spectrally determine parameters, color values and spectral information.

Questions ?

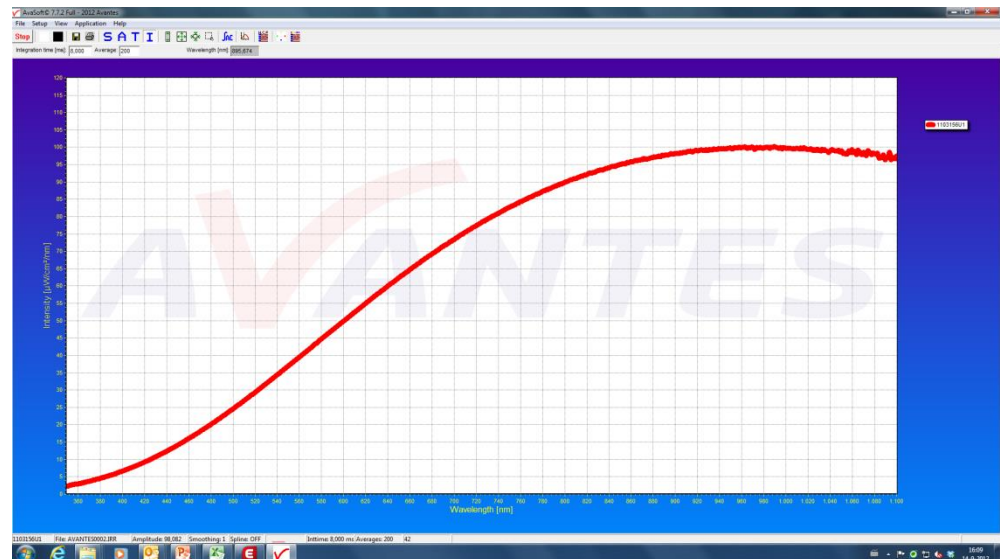
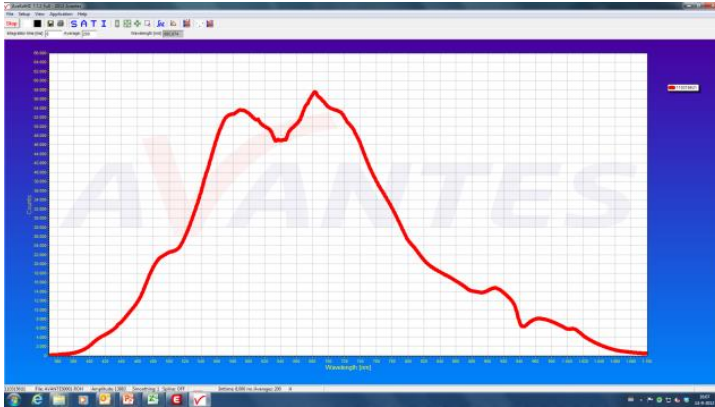


Thank you for your attention



Visit us at Stand 30

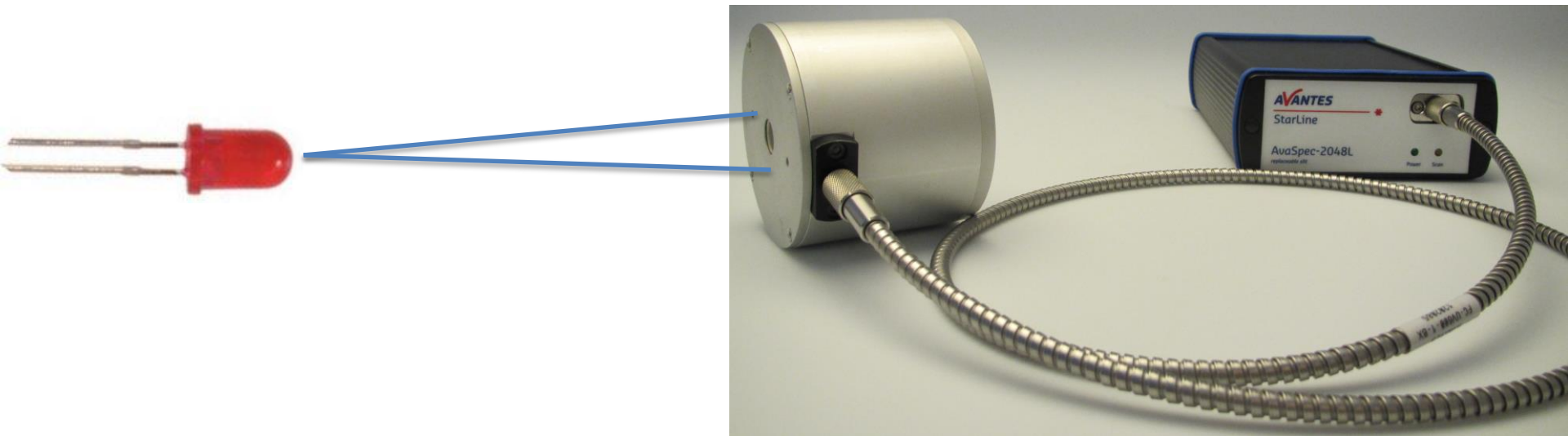
Measuring with calibrated spectrometers



Radiometric / Photometric Flux

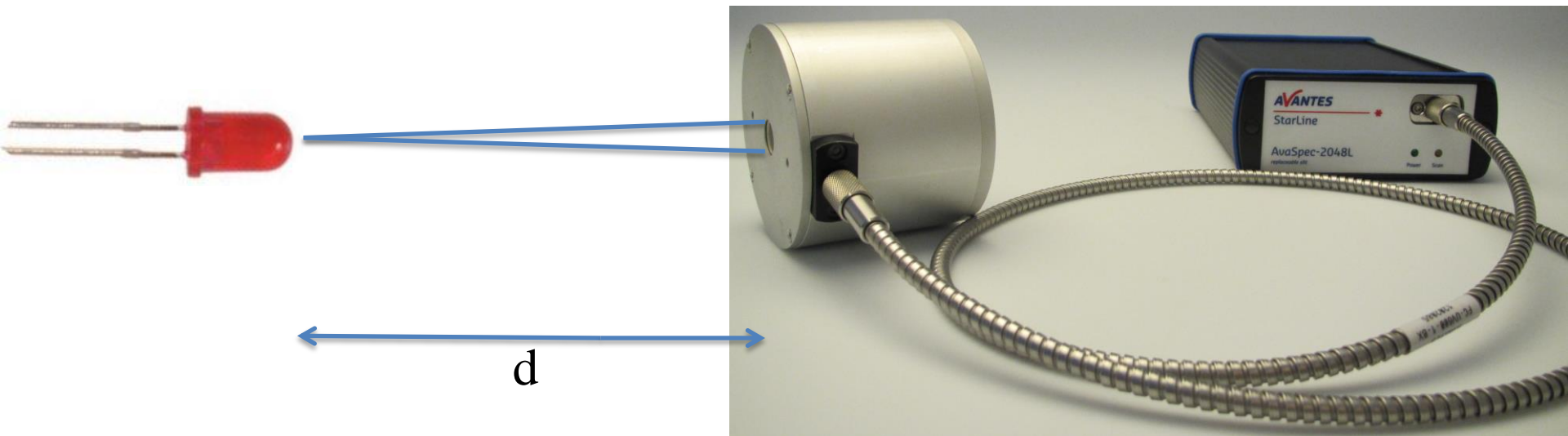


Unit: W or lm



Unit: W/cm^2 or $\text{lm}/\text{cm}^2=\text{lx}$

Radiant / Luminous Intensity



Unit: W/sr or $\text{lm/sr}=\text{cd}$